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A GRAPHIC METHOD FOR COMPARING SEVERAL SETS OF MEASUREMENTS

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BY several lines constructed as described in the following paragraph, a statistical comparison can quickly be made between a number of sets of measurements of any particular character. William D. Baten of the Department of Mathematics, University of Michigan, has assisted in developing this graphic method.

On graph paper the possible magnitudes of the character are laid off as ordinates. The extreme limits of variation of each set of measurements are represented by a single line. A bar drawn across the line represents the mean. Double lines are extended above and below this crossbar to other crossbars placed three times the probable error (= two times the standard error) of the mean above and below the mean, respectively, thus forming a rectangle. For each set of measurements to be compared a separate line and its rectangle are drawn in proper position on the graph. Figure 1 is presented as an example of the method.

If we assume two sets of measurements in which the probable errors of the means are exactly equal and if, further, we assume that the value of one mean plus three times its probable error exactly equals the value of the other mean minus three times its probable error, then the difference between the two means will be 4.24 times the probable error of the difference. On a graph this hypothetical situation will occur when the lower crossbar of the rectangle of one line lies on the same ordinate as the upper crossbar of the rectangle of the other line.

In the foregoing example (where the rectangles of two lines meet, but do not overlap in vertical position) if, instead of the probable errors of the two means being equal in magnitude, the probable error of one mean were one and one-half times greater than the probable error of the other mean, the difference between the two means would be 4.16 times its probable error. If the probable error of one mean were two times as great as the probable error of the other mean, the difference between the two means would be 4.03 times its probable error. If the probable error of one mean were three times, four times, or an infinite number of times greater than the probable error of the other mean, the differences between the two means would be respectively 3.79, 3.64, or 3.00 times their probable errors.

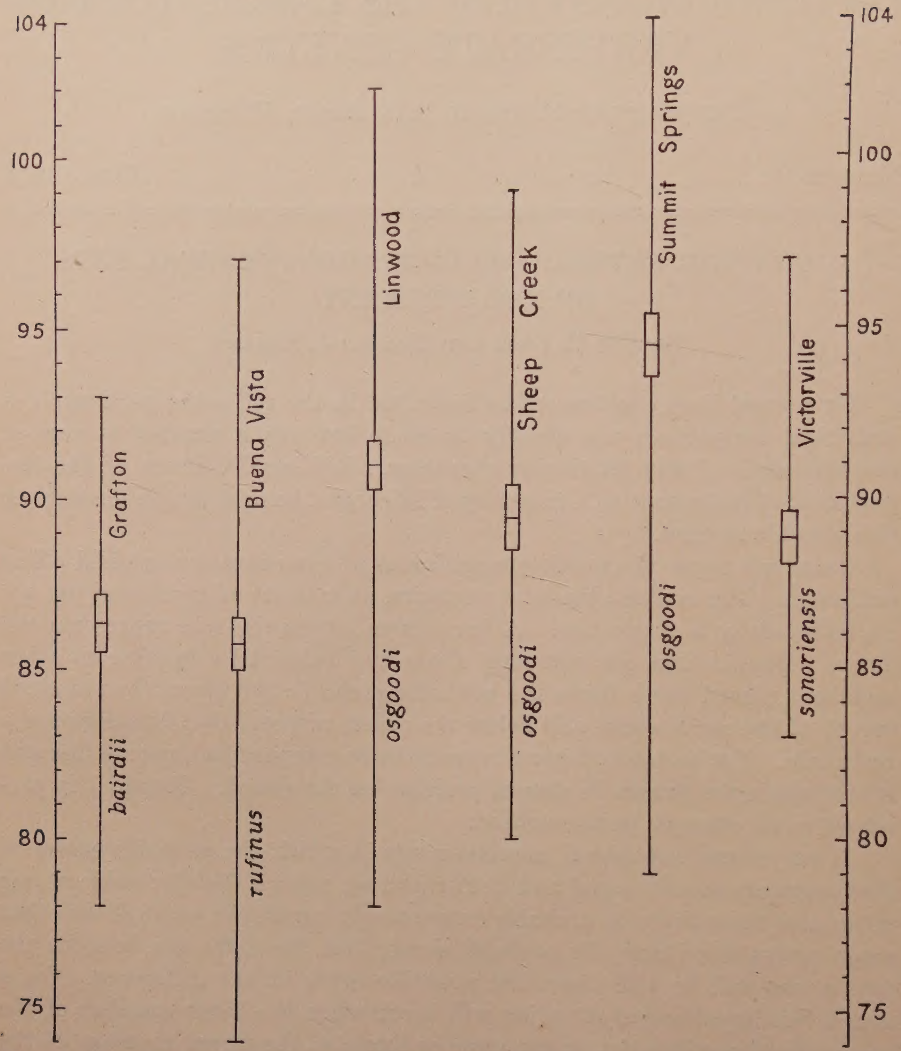

FIG. 1. Graph of body lengths in millimeters of several stocks of *Peromyscus maniculatus.* The length of each line represents the extremes of that set of measurements. The middle crossbar represents the mean. Two other crossbars are placed three times the probable error (= two times the standard error) of the mean above and below the mean, respectively, forming a rectangle. If the rectangles of two comparable lines do not overlap in vertical position the two means are indicated to differ by a statistically significant amount. For example, in body length the Linwood stock does not differ significantly from the Sheep Creek stock, but it is significantly shorter than the Summit Springs stock, and is significantly longer than either the Victorville, Grafton, or Buena Vista stocks.

In the great majority of comparisons the probable error of one mean will not be greater than twice that of the other mean. Then, in the above hypothetical example, the difference between the two means will usually be from about 4.0 to 4.2 times its probable error. It is assumed by many statisticians that a difference 4.5 times its probable error indicates practical freedom from chance. Therefore, a difference which is between 4.0 and 4.2 times its probable error may be considered to be close to the dividing line between differences which are statistically significant and those which are not.

It follows that if the rectangles of any two lines overlap in vertical position on a graph the difference between the two means is probably not of statistical significance, being less than 4.2 times its probable error. On the other hand, if the rectangles of two lines do not overlap in vertical position there is considerable probability that the difference between the two means is of statistical importance, for the difference will usually be more than four times its probable error. The farther any two rectangles are spaced vertically, the greater is the probability that the difference between the corresponding means is due to some factor other than chance.

On a graph constructed in the manner described above any number of lines may be drawn, each representing a separate set of measurements. By a straight-edge any two sets of measurements on the graph may be compared. For the comparison of a number of sets of measurements this method saves much time, for it is not necessary to calculate the probable error of the difference between each possible pair of means.